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REMOTE VEHICLE SECURITY SYSTEM

Technical Field of the Invention

[0001] The present invention relates generally to the field of selectively limiting one or more operational performance characteristics of a vehicle.

Background of the Invention

[0002] An owner or operator of a vehicle may desire to limit the operational performance of his/her vehicle for many reasons. For example, in the event of a security breach, such as a car-jacking or other similar circumstance, the owner or operator of his/her vehicle may find it desirable to be able to cause the vehicle to enter a limited operational mode whereby the operational performance characteristics, such as maximum speed, is limited. In this way, certain security breaches in an automobile may be averted, or at least, the resulting negative effects minimized. The desirability of being able to limit the operational performance of a vehicle is even more acute for an owner of a fleet of commercial vehicles, such as commercial trucks and the like, which are very expensive and commonly carry expensive and/or hazardous cargo, and which are normally driven by employees.

Summary of the Invention

[0003] The present invention relates to a new system and related method for limiting the operational performance of a vehicle. In one embodiment of the invention, one or more operational performance characteristic, such as maximum vehicle speed, of the vehicle can be selectively limited in response to a remotely-issued vehicle limitation

control signal communicated to the vehicle over a wireless communication network. The vehicle includes a device for receiving the control signal, and, based thereon, limiting a performance characteristic of the vehicle. A variety of systems and methods are employed to limit the speed of the vehicle in response to the vehicle limitation control signal.

Brief Description of the Drawings

[0004] Figure 1 illustrates an exemplary environment in which the present invention can be implemented.

[0005] Figure 2 illustrates an exemplary command device according to an embodiment of the invention.

[0006] Figure 3 illustrates a first exemplary embodiment of the invention.

[0007] Figure 4 sets forth a flowchart illustrating an exemplary algorithm that could be used to implement the first exemplary embodiment of the invention.

[0008] Figure 5 illustrates a second exemplary embodiment of the invention.

[0009] Figure 6 illustrates an exemplary primary pulse train produced by a throttle position sensor and an exemplary secondary pulse train produced by an MPU, according to an embodiment of the invention.

[0010] Figure 7 sets forth a flow chart that illustrates an exemplary algorithm that could be used to implement the second exemplary embodiment of the invention.

[0011] Figure 8 sets forth a flow chart that illustrates an exemplary algorithm that could be used to implement the second exemplary embodiment of the invention.

[0012] Figure 9 sets forth a flow chart that illustrates an exemplary algorithm that could be used to implement the second exemplary embodiment of the invention.

[0013] Figure 10 illustrates additional features that could be used in connection with an embodiment of the invention.

Detailed Description of an Embodiment

[0014] The present invention relates to limiting one or more performance characteristics of a vehicle, such as maximum vehicle speed, in response to a vehicle limitation control signal. Figure 1 illustrates an exemplary environment in which the described embodiment of the invention can be implemented. The environment 1 includes a command device 10 configured to issue a vehicle limitation control signal indicative of a desire of a human operator of the command device to limit one or more performance characteristics of a vehicle 14. The command device 10 can comprise many different known electronic devices, such as a personal computer, a personal digital assistant (PDA), a wireless phone, a pager, or a variety of other electronics capable of creating a control signal. The control signal is indicative of a desire to cause the vehicle 14 to enter a vehicle limitation mode, whereby its maximum speed (or other performance characteristic) is limited. The vehicle limitation control signal may preferably be generated remote from the vehicle 14 and communicated to the vehicle 14 over a wireless communication network 12. The wireless communication network 12 can comprise any one of a variety of known wireless communication networks that is capable of transmitting signals from a source device to a destination device in a wireless fashion. In addition to the features illustrated in Figure 1, other components could be included in the environment 1 as well. For example, the command device 10 could be connected to a local area network (LAN) or wide area network (WAN), such as the Internet, and control

signals issued by the command device 10 could be transmitted first through such a LAN or WAN and then through the wireless communication network 12 to the vehicle 14. Other variations of this environment are also contemplated to be within the scope of the present invention.

[0015] Though not illustrated in Figure 1, it is contemplated that the vehicle limitation control signal that initiates the limited performance mode of the vehicle can also be generated locally from within the vehicle. For example, it is contemplated that a local command device, such as a switch or button, could be installed inside of the vehicle so that a vehicle operator could initiate the limited performance mode on the vehicle. It is further contemplated that, depending on the particular embodiment of the invention, the limited performance mode could be activated by: (i) a remotely-issued control signal only (as illustrated in Figure 1); (ii) a locally-issued control signal only (as described above); or (iii) either a remotely-issued control signal or a locally-issued control signal. A remotely-issued control signal can be initiated by, for example, a manager of a commercial fleet of vehicles, whereas a locally-issued control signal can be issued by the driver.

[0016] When a particular embodiment of the invention includes the ability to remotely-issue the control signal, the vehicle 14 is configured with a signal-receiving device mounted thereon, which is capable of receiving a wirelessly-transmitted control signal. The signal-receiving device will typically include an antenna and receiver for receiving the control signal and, possibly, a means for storing, modifying, adjusting or otherwise causing the received control signal to be converted into a format that is usable by the system to limit one or more operational performance characteristics of the vehicle. Various signal-receiving devices are known to those of skill in the art. One example of a

known signal-receiving device is commercially-available from the assignee hereof under the trademark, PRISM™. Other signal-receiving devices can also be used in connection with the invention.

[0017] Figure 2 sets forth an illustrative signal-receiving device 16, which could be mounted to the vehicle 14. The signal-receiving device may receive the vehicle limitation control signal 18 (from the remotely-located command device 10) via antenna 17. Though not shown in Figure 2, the signal-receiving device may also (or alternatively) receive a vehicle limitation control signal from a command device locally-mounted to or in the vehicle 14 and operable by the driver of the vehicle. When the signal-receiving device 16 relays a vehicle limitation control signal (either from a remote or local command device), the signal-receiving device 16 provides a vehicle limitation signal 20. The signal-receiving device 16 may be configured to modify or otherwise adjust the nature of the received control signal 18, when generating the vehicle limitation signal, into any useable format. Further, in the event that the embodiment of the invention includes a locally-mounted command device only (i.e., not configured to receive remotely-issued control signals), the locally-mounted command device may supply the vehicle limitation signal 20 directly. Further, a vehicle limitation signal 20 may be automatically activated for various other reasons, such as if the vehicle 14 loses communication with the command device 10.

[0018] The signal-receiving device 16 provides the vehicle limitation control signal 20 to a control circuit or control module in order to limit one or more operational performance characteristics of the vehicle 14. Various systems and methods can be used to limit operational performance characteristics of a vehicle. Exemplary systems and methods for limiting the maximum speed of a vehicle are described hereinafter.

[0019] A first exemplary system and method for limiting the maximum speed of a vehicle in response to a vehicle limitation signal 20 is set forth in Figure 3. This exemplary system and method is particularly applicable to vehicles, such as heavy-duty trucks, that incorporate SAE J1922 control link, defined by the Society of Automotive Engineers (SAE). Under this embodiment of the invention, the vehicle limitation control signal 20 is provided to a microprocessor unit (MPU) 22 (sometimes referred to herein as a "controller"). The vehicle limitation control signal 20 may be provided to the MPU 22 via a discrete input terminal 19 in the form of a binary electrical signal, i.e., either a "high" or "low" state, one of which states indicating a desire to limit the maximum vehicle speed. Alternatively, the vehicle limitation signal 20 may be provided to the MPU 22 via an SAE J1708 data bus 34, through an RS 285 interface 30 and a Universal Asynchronous Receiver/Transmitter (UART) device 26, in which case the vehicle limitation signal 20 would conform to SAE J1587 format. Other methods of supplying a vehicle limitation signal to the MPU may also be used. Regardless of the manner in which the vehicle limitation signal 20 is provided to the MPU 22, the vehicle limitation signal 20 causes the MPU 22 to initiate a vehicle limitation mode by issuing commands to the vehicle's Engine Control Module (ECM) over the SAE J1922 control link 32 via UART 24 and RS 485 interface 28.

[0020] The SAE J1922 control link standard defines a particular command code that can be issued over the J1922 control link to limit the engine speed and torque rating of the vehicle (referred to hereinafter as the "speed limit command code". The speed limit command code should be transmitted to the J1922 control link at least every 250ms for as long as the vehicle limitation mode is engaged. Accordingly, under this embodiment of the invention, the MPU 22, in response to receiving an activated vehicle

limitation control signal 20, causes a speed limit command code to be issued over the J1922 control link at least every 250ms while the vehicle limitation mode is engaged.

[0021] Figure 4 illustrates an embodiment of an algorithm that can be used to control the transmission of speed limit command codes to the J1922 control link. Upon startup of the routine, a broadcast timer is started at block 402. Because the J1922 standard recites that a speed limit command code be transmitted at least every 250ms to maintain a maximum vehicle speed in place, the broadcast timer is preferably a 250ms broadcast timer. At block 404, the broadcast timer is queried to determine if a timeout has occurred. The broadcast timer is continuously monitored to determine when a timeout has occurred. When a timeout occurs, the broadcast timer is reset and a J1922 vehicle limitation flag is tested at block 406. The J1922 vehicle limitation flag is preferably a binary indicator that stores whether or not the vehicle is in limitation mode. If the vehicle limitation flag is "1" (indicating that the MPU 22 has received an active vehicle limitation signal 20), then the MPU 22 transmits a speed limit command code over the J1922 control link (shown in block 410). If the vehicle limitation flag is "0" (indicating that the MPU has not received an active vehicle limitation signal 20), then the MPU 22 does not transmit a speed limit command code. In either event, the MPU 22 next queries the vehicle limitation signal 20, as shown in blocks 412 and 414. If the vehicle limitation signal 20 indicates that the vehicle should be in vehicle limitation mode, then the vehicle limitation flag is set to "1", as shown in block 416. If the vehicle limitation control signal 20 does not indicate that the vehicle should be in a vehicle limitation mode, then the vehicle limitation flag is set to "0", as shown in block 418. Then, control of the algorithm is looped back to block 404, where the broadcast timer is again continuously queried until a timeout occurs, and the routine is repeated. In this

way, whenever the vehicle limitation flag is set (resulting from the receipt of an active vehicle limitation control signal 20, either over the input line 19 or the J1708 data bus 34), the MPU 22 transmits the speed limit command code over the J1922 control link to the ECM once every 250ms, which limits the maximum speed of the vehicle. Preferably, the above-described routine is implemented in software or hardware to the MPU 22.

[0022] Figure 5 illustrates a second exemplary embodiment of a system and method that can be used for limiting the maximum speed of a vehicle in response to a vehicle limitation control signal 20. Components in Figure 5 that are the same as those in Figure 3 bear the same reference numerals. As in the first exemplary embodiment, the vehicle limitation control signal 20 can be provided to the MPU 22 either through a discrete signal input 19 or across the J1708 data bus 34. In response to receiving a vehicle limitation control signal 20 indicative of a desire to limit the performance characteristics of the vehicle 14, the MPU 22 limits the output of the vehicle's electronic throttle pedal (not shown), which is provided to the vehicle's ECM. The present embodiment assumes that the vehicle employs one of two possible electronic throttles that are known in the art: (i) a resistive throttle; or (ii) a pulse-width modulated throttle. As one skilled in the art will understand, a resistive throttle generally involves adjusting a variable resistance between a constant application voltage in response to an operator command, such as an adjustment of an accelerator pedal. The voltage drop across the variable resistance determines the throttle output and thus the vehicle speed. As one skilled in the art will further understand, a pulse-width modulated throttle is configured to produce a pulse-width modulated signal (i.e. a "pulse train") to the vehicle's ECM, wherein the width and frequency of the pulses are indicative of the desired vehicle speed.

[0023] Figure 5 illustrates four sets of jumpers J1(A&B), J2(A&B), J3(A&B), and

J4(A&B), which allow a single physical implementation of this embodiment of the invention to be used with a wide variety of vehicles, regardless of whether they have a resistive throttle or a pulse-width modulated throttle. If the vehicle uses a resistive throttle, then jumpers J1A, J2A, J3A, and J4A are connected, and if the vehicle uses a pulse-width modulated throttle, then jumpers J1B, J2B, J3B, and J4B are connected. It is also within the scope of this invention to implement a physical embodiment that can be used with *either* a resistive throttle or a pulse-width modulated throttle, but not both, in which case jumpers J1, J2, J3, and J4 could be eliminated. For purposes of description, it is first assumed that the presently-described embodiment of the invention is installed on a vehicle that uses a resistive throttle, and that, accordingly, jumpers J1A, J2A, J3A, and J4A are connected. During normal operation, relay CR1A is in the "B" position and CR1B is in the "A" position. The normal position of relay CR1A allows the vehicle's Engine Control Module (ECM) to provide a constant voltage (V+) through jumper J1A over line 42 to the vehicle's throttle pedal (not shown). Usually, the constant voltage is nominally 5 volts. Further, the normal position of relay CR1B allows the ECM to respond to the driver's engagement of the vehicle's cruise control on/off switch. In response to movement of the vehicle's accelerator pedal (not shown), the variable resistance of the throttle position sensor coupled between the V+ voltage and ground is adjusted, which, in turn, adjusts the voltage drop across the variable resistance. The voltage drop across the variable resistance controls the output of the throttle position sensor, which is provided over line 44 through jumper J2A to the vehicle's ECM. The ECM uses the throttle position sensor output to control the vehicle's RPM level and thus the vehicle speed.

[0024] When the vehicle limitation control signal 20 is activated (or an

appropriate signal is received over the J1708 data bus), the MPU 22 establishes a V+ output on the D/A converter 40 identical to that supplied from the ECM. The MPU 22 activates relay CR1 (A&B) such that CR1A moves from position "B" to position "A" and CR1B moves from position "A" to position "B". The activation of relay CR1 simultaneously disengages the vehicle's cruise control enable switch and switches the input to the throttle position sensor (not shown) over line 42 from the constant V+ supplied by the ECM to the V+ output on the D/A converter 40. Then, the MPU 22 gradually decreases the V+ voltage of the D/A converter 40 to a lower voltage corresponding to the maximum engine RPM allowed to produce the desired maximum speed of the vehicle. As the voltage from the D/A converter 40 is reduced, so is the maximum output from the throttle position sensor supplied to the vehicle's ECM over line 44. Generally, a 1.2 volt output from the D/A converter 40 will impose a limit of 1200 RPM on the engine. As long as the reference voltage supplied to the throttle position sensor is limited, the maximum speed of the vehicle will be limited because the maximum output from the throttle position sensor (supplied to the ECM) directly corresponds to the reference voltage supplied to the throttle position sensor. Though the *maximum* speed f the vehicle is limited, it is still possible for the driver to completely control the speed of the vehicle in a normal fashion at any level *up to* the limited speed.

[0025] Now, it is assumed that the presently-described embodiment of the invention is installed on a vehicle having a pulse-width modulated throttle. Accordingly, jumpers J1B, J2B, J3B, and J4B are connected. During normal operation, relay CR2 is deactivated such that CR2A is in the "A" position and CR2B is in the "B" position. As a result, the throttle position sensor can provide a train of pulses (sometimes referred to herein as the "primary pulse train") over line 44 through jumper J2B to the vehicle's

ECM. Normally, the width of the pulses is determined solely by the position of the vehicle's accelerator pedal. Further, if requested by the vehicle operator, the ECM can issue a signal through J4B and line 46 to the vehicle's cruise control switch to turn the vehicle's cruise control function on, if desired by the driver.

[0026] When the MPU 22 receives a vehicle limitation signal 20 (or appropriate J1708 message), the MPU 22 sets the PWM output line 50 "high" and then activates relay CR2, which causes CR2A to move to position "B" and CR2B to move to position "A". The activation of CR2A causes the ECM to receive its throttle input on line 52 through the "AND" gate 54. The activation of CR2B disengages the cruise control engage switch. At this point, with the signal on line 50 being held "high", the pulse train from the throttle position sensor is allowed to simply pass through to the ECM. To limit the vehicle's RPM and speed, the MPU 22 samples the pulse train from the throttle position sensor on its PWM sense input line 48, and, using an internal timer, establishes a matching pulse train, having an identical duty cycle and pulse width. The matching pulse train is supplied by the MPU 22 on the PWM output line 50 to the "AND" gate 54 (sometimes referred to herein as the "secondary pulse train"). Again, while the pulse train supplied by the vehicle's throttle position sensor and the pulse train supplied by the MPU mirror each other, the input to the ECM over line 52 will be the same as the pulse train generated by the throttle position sensor, thus making the vehicle appear to operate normally to the driver. To limit the vehicle's speed, the MPU 22 gradually reduces the width of the pulses that it generates on the PWM output line 50 and provides to the "AND" gate 54. Since the output of the "AND" gate is "high" only when both inputs are "high", the shorter pulses generated by the MPU will limit the width of the pulses supplied to the ECM on line 52 (sometimes referred to herein as a "limited pulse train"). The MPU

gradually decreases the width of the pulses output on line 50 to a level that corresponds to the maximum desired vehicle RPM. As long as relay CR2A is in position "B" and the width of the pulses supplied by the MPU 22 is limited, the maximum speed of the vehicle will be limited.

[0027] Figure 6 illustrates an exemplary primary pulse train supplied by the vehicle's throttle position sensor and a corresponding secondary pulse train supplied by the MPU 22. A third pulse train is also depicted in Figure 6, which illustrates an exemplary output pulse train from the AND gate 54. The first portion (from left to right) of Figure 6 illustrates a time when the vehicle limitation mode is first engaged and the PWM output line 50 is set to "high" such that the primary pulse train remains in control of the throttle input signal to the vehicle's ECM. The middle portion of Figure 6 illustrates a time when the MPU 22 creates a secondary pulse train on the PWM output line 50 that mirrors the primary pulse train. The third portion of Figure 6 illustrates a time when the MPU 22 reduces the width of the pulses making up the secondary pulse train such that the secondary pulse train controls the throttle input signal (output of the AND gate 54) to the vehicle's ECM.

[0028] Figures 7-9 set forth flowcharts of exemplary algorithms that can be employed by the MPU 22 to implement the above-described embodiment of the invention. Figure 7 illustrates an exemplary mainline algorithm for controlling the MPU 22. The mainline algorithm begins at block 702. As shown in block 704, upon power-up, the MPU 22 performs any appropriate reset functions. At block 706, the MPU 22 queries a non-volatile memory location to determine if a vehicle limitation disengage flag is set to "1". The vehicle limitation disengage flag is stored in non-volatile memory so that the vehicle limitation mode cannot be reset merely by turning the vehicle off and restarting it.

If the vehicle limitation disengage flag is set to "1", the vehicle limitation mode is disengaged by clearing the vehicle limitation flag and a disengage flag, shown at block 708. Next, shown at block 710, the MPU 22 reads the vehicle limitation signal line 19 and/or the J1708 data bus, depending upon the method used to supply the vehicle limitation signal 20 to the MPU 22. Then the MPU 22 determines if a vehicle limitation control signal 20 has been provided, as shown at block 712. If so, at block 714 the MPU 22 determines if the vehicle limitation control signal is indicative of a disengage message or an engage message. If the message is indicative of an engage command, the MPU 22, at block 718, clears the vehicle limitation disengage flag, sets the vehicle limitation flag and performs the appropriate vehicle limitation function (as described in more detail hereinafter), depending upon whether the vehicle uses a resistive throttle position sensor or a pulse-width-modulated throttle position sensor. If the message is indicative of a disengage command, the MPU 22, at block 716, sets the vehicle limitation disengage flag. Regardless of the nature of the message, control of the algorithm is then transferred back to block 710, where the MPU 22 again queries the vehicle limitation signal line 19 or the J1708 data bus 34, as the case may be.

[0029] As can be appreciated from reviewing Figure 7, this embodiment of the invention preferably allows the vehicle limitation mode be disengaged upon the MPU receiving a disengage signal over line 19 or the J1708 data bus *and* upon the vehicle being turned off and restarted. That is, once a vehicle limitation mode is engaged, it can only be disengaged after the vehicle has been turned off and restarted. This feature, though not necessary to accomplish the basic goal of limiting the performance of the vehicle, is an optional safety feature. When the vehicle is in vehicle limitation mode, it is probable that the driver will be holding the accelerator in its maximum position. If the

vehicle limitation mode were to be abruptly disengaged while the driver was holding the accelerator in its maximum position, the driver could conceivably lose control the vehicle as a result of the abrupt change in speed of the vehicle. Accordingly, this particular embodiment of the invention requires that the vehicle be turned off and restarted before disengaging the vehicle limitation mode.

[0030] Figure 8 illustrates a flowchart of an exemplary algorithm that could be used to implement the vehicle limitation mode on a vehicle that uses a resistive throttle position sensor. The algorithm shown in Figure 8 would be called from block 718 of Figure 7. The resistive vehicle limitation algorithm begins at block 802. At block 804, the MPU 22 sets the output of the D/A 40 to V+ volts to match the V+ volts normally provided to the variable resistance of the throttle position sensor by the ECM. As indicated above, V+ is typically a nominal 5 volts. At block 806, the MPU 22 energizes relay CR1, which, as described above, disengages the vehicle's cruise control and connects the throttle pedal to the output of the D/A converter 40 instead of the V+ reference voltage provided from the ECM. Then, at block 808, the MPU 22 gradually reduces the output of the D/A converter 40 to a level corresponding to a desired maximum engine RPM. Then, at block 810, control is returned to the mainline algorithm illustrated in Figure 7.

[0031] Figure 9 illustrates an exemplary algorithm that could be used to implement the vehicle limitation mode on a vehicle that uses a pulse-width-modulated throttle position sensor. As above, the algorithm set forth in Figure 9 would be called from block 718 of the mainline algorithm illustrated in Figure 7. The pulse-width modulation vehicle limitation algorithm starts at block 902. At block 904, the pulse train currently being supplied to the ECM by the throttle position sensor over line 44 is

sampled at PWM sense input 48. This is done so that the MPU 22 can initially emulate the pulse train currently being supplied from the throttle position sensor to the ECM. At block 906, the MPU 22 sets the PWM output line 50 to "high" so that the output of "AND" gate 54 will simply reflect the pulse train currently being supplied from the throttle position sensor to the ECM. At block 908, the MPU 22 energizes relay CR2, which, as described above, disengages the vehicle's cruise control and switches the signal received by the ECM throttle position input to be the output of the "AND" gate 54. At blocks 910 and 912, the MPU causes the signal output on the PWM output line 50 to emulate the pulse train received on PWM sense input 48. As a result, the two inputs to the "AND" gate 54 are identical. Then, at block 914, the MPU 22 causes the width of the pulses generated by the MPU 22 on PWM output line 50 to slowly get shorter until a target pulse width is attained that corresponds to a maximum desired engine RPM. After the target pulse width is attained on PWM output line 50, control is returned (at block 916) to the mainline algorithm illustrated in Figure 7.

[0032] One skilled in the art will recognize, in light of this disclosure, that it is desirable to incorporate multiple systems and methods for limiting the speed of the vehicle into a single physical module. In this way, a single module can be used on a variety of vehicles that have different capabilities and different throttle position sensors. Depending on the features needed, the communication capabilities of the vehicle, and the type of equipment (including throttle position sensor) already present on the vehicle, an installer of the module can customize the module on-site by connecting different jumpers.

[0033] Figure 10 illustrates an embodiment of the present invention having additional features above and beyond those shown in Figure 5. The components of Figure 5 that are common to the embodiment of the invention illustrated in Figure 10

have identical reference numerals. New to the embodiment illustrated in Figure 10 are two new external relays CR3 and CR4 and related circuitry 56. In this embodiment of the invention, relay CR3 is installed in the signal line 58 between the vehicle's ignition switch and the ECM. With relay CR3 in place, the MPU 22, in response to the receipt of an active vehicle limitation signal 20 (from either the vehicle limitation input 19 or the J1708 data bus 34), can activate CR3, thereby switching CR3 from its normal "A" position to its "B" position. When relay CR3 is in the "B" position, the signal line between the vehicle's ignition switch and the vehicle's ECM is broken, thus shutting the vehicle down.

[0034] Further, Figure 10 illustrates a vehicle speed sensor + line 60 and vehicle speed sensor – line 62, which connect the vehicle's speed sensor to the vehicle's ECM. According to this embodiment of the invention, relays CR4A and CR4B are inserted into the signal lines 60 and 62. When the MPU 22 receives an active vehicle limitation control signal 20, it activates relay CR4, which breaks the connection between the vehicle's speed sensor and the vehicle's ECM. In certain known engines, such as the Cummins ISx series engines and certain Mack engines, the vehicle's ECM automatically imposes a maximum engine RPM when the vehicle's speed sensor no longer provides a speed sensor signal to the ECM. By breaking the connection between the vehicle's speed sensor and the vehicle's ECM by switching relay CR4 from its "A" position to its "B" position, the ECM on these engines will automatically limit the engine RPM output to a relatively low maximum level.

[0035] The additional relays CR3 and CR4 and the additional control circuitry 56 shown in Figure 10, when desired, can be implemented in connection with or separate from the other features of the embodiment shown in Figure 10. For example, in some

applications, the use of relay CR4 to break the signal line between the vehicle's speed sensor and the vehicle's ECM may allow for sufficient control of the vehicle, thereby eliminating the desire to incorporate the throttle control methods described above in connection with Figures 8 and 9. Similarly, the inclusion of relay CR3 may or may not be desirable, depending on the situation.

[0036] It is contemplated that the various systems and methods described herein for limiting the operational performance characteristics of the vehicle in response to a control signal – such as that described in connection with Figures 3 and 4, or that described in connection with Figures 5-9, or that described in connection with Figure 10 – can be selectively used together or alone to implement the present invention. It is further contemplated that various aspects of the above-described embodiments can be physically incorporated into other communication and control modules that may already exist on vehicles.

[0037] While the present invention has been particularly shown and described with reference to the foregoing preferred and alternative embodiments, those skilled in the art will understand that many variations may be made therein without departing from the spirit and scope of the invention as defined in the following claims. This description of the invention should be understood to include all novel and non-obvious combinations of elements described herein, and claims may be presented in this or a later application to any novel and non-obvious combination of these elements. The foregoing embodiments are illustrative, and no single feature or element is essential to all possible combinations that may be claimed in this or a later application. Where the claims recite "a" or "a first" element of the equivalent thereof, such claims should be understood to include incorporation of one or more such elements, neither requiring nor excluding two or more

such elements. The invention is limited by the following claims.

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CLAIMS

1. A system for limiting performance of a vehicle, comprising:

a command device configured to send a control signal over a wireless communication network to a remotely-located vehicle;

a receiving device located on said vehicle configured to receive said control signal; and

a controller configured to cause an operational performance characteristic of said vehicle to be limited in response to said control signal.

2. The system of claim 1, wherein said limited operational performance characteristic of said vehicle is speed.

3. The system of claim 1, wherein said command device is selected from a group comprising the following: (i) a computer; (ii) a personal digital assistant (PDA); (iii) a wireless telephone; and (iv) a pager.

4. The system of claim 1, wherein said controller receives said control signal over an SAE J1708 data bus.

5. The system of claim1, wherein said controller is configured to transmit a vehicle limitation command message over an SAE J1922 data link to an ECM of said vehicle in response to said control signal.

6. The system of claim 5, wherein said controller is configured to transmit said vehicle limitation command message at least once every 250ms.

7. The system of claim 5, wherein said controller is configured to cause a vehicle limitation flag to be stored in non-volatile memory, said vehicle limitation flag indicating if it is desired to maintain said vehicle in a vehicle limitation mode.

8. The system of claim 1, wherein said controller is configured to adjust a throttle position sensor signal supplied to an ECM of said vehicle in response to said control signal.

9. The system of claim 8, wherein said vehicle employs a resistive throttle position sensor, and said controller is configured to cause a reference voltage supplied to said throttle position sensor to be reduced such that a maximum output of said throttle position sensor is reduced.

10. The system of claim 8, wherein said vehicle employs a pulse-width-modulated throttle position sensor, and wherein said controller is configured to cause a width of pulses supplied to said ECM to be reduced in response to said control signal.

11. The system of claim 10, wherein said width of pulses supplied to said ECM is reduced by providing a pulse train from said throttle position sensor and a pulse train from said controller to a comparator device, said pulse train from said controller having pulses of shorter duration than said pulses provided by said throttle position sensor.

12. The system of claim11, wherein said comparator device is an AND gate.

13. The system of claim 1, wherein said controller is further configured to cause a cruise control switch of said vehicle to be disabled.

14. The system of claim 1, wherein said controller is configured to cause an operational performance characteristic of said vehicle to be limited in response to said control signal by causing a disconnection of a vehicle speed sensor on said vehicle.

15. The system of claim 1, wherein said controller is further configured to cause an ignition switch on said vehicle to be disconnected.

16. The system of claim 1, wherein said controller is configured to cause said operational performance characteristic of said vehicle to be limited by selectively taking one of the following actions: (i) providing a vehicle limitation command on an SAE J1922 data link; and (ii) adjusting a throttle position sensor signal supplied to an ECM of said vehicle.

17. The system of claim 16, wherein said vehicle employs a resistive throttle position sensor, and said controller is configured to adjust said throttle position sensor signal by causing a reference voltage supplied to said throttle position sensor to be reduced such that said output of said throttle position sensor is reduced.

18. The system of claim 16, wherein said vehicle employs a pulse-width-

modulated throttle position sensor, and said controller is configured to adjust a throttle position sensor signal supplied to said ECM by causing a width of pulses supplied to said ECM to be reduced.

19. The system of claim 1, further comprising a means for locally issuing a control signal to said controller from within said vehicle.

20. A module for limiting an operational performance characteristic of a vehicle, comprising:

a throttle position sensor;

a primary reference voltage normally coupled to said throttle position sensor; and

a means for selectively providing a limiting reference voltage to said throttle position sensor in response to a control signal, said limiting reference voltage being less than said primary reference voltage.

21. The module of claim 20, wherein said means for providing a limiting reference voltage comprises:

a controller having an input port for receiving a limitation control signal, said controller having an output terminal coupled to a voltage-generating device, said voltage-generating device generating said limiting reference voltage; and

a switching device responsive to said controller, said switching device configured to selectively connect said primary reference voltage to said throttle position sensor and to alternatively connect said limiting reference voltage to said throttle position sensor.

22. A module for limiting an operational performance characteristic of a vehicle, comprising:

a throttle position sensor configured to generate a primary pulse train; and

a means for providing a limiting pulse train to an ECM of said vehicle in response to a control signal, wherein a width of pulses making up said limiting pulse train are shorter than a width of pulses making up said primary pulse train.

23. The module of claim 22, wherein said means for providing a limiting pulse train to an ECM of said vehicle comprises:

a controller having an input port for receiving a control signal and an output terminal for providing a secondary pulse train; and

a means for deriving said limiting pulse train based at least upon said secondary pulse train.

24. The module of claim 22, wherein said deriving means comprises a comparator device.

25. The module of claim 24, wherein said comparator device is an AND gate having said primary pulse train and said secondary pulse train as inputs, wherein an output of said AND gate comprises said limiting pulse train.

26. A module for limiting a performance characteristic of a vehicle, comprising:

a throttle position sensor;

a controller having an output terminal that selectively causes a limiting reference voltage to be applied to said throttle position sensor, said limiting reference voltage being less than a primary reference voltage that is applied to said throttle position sensor during normal operation; and

said controller having an output terminal that selectively provides a secondary pulse train upon which a limiting pulse train can be derived, said limiting pulse train being provided to an ECM of said vehicle.

27. The module of claim 26, further comprising means for applying said limiting reference voltage when said throttle position sensor is based upon a variable resistance and for deriving said limiting pulse train when said throttle position sensor produces a primary pulse train.

28. The module of claim 26, wherein said controller is further configured to receive a control signal and to selectively transmit a vehicle limitation command message over an SAE J1922 data link.

29. The module of claim 26, further comprising a comparator device configured to derive said limiting pulse train based upon said secondary pulse train and a primary pulse train.

30. The module of claim 29, wherein said comparator device is an AND gate.

31. A method for limiting a performance characteristic of a vehicle,

comprising the steps:

receiving a vehicle limitation control signal over a wireless communication network; and

limiting a maximum speed of the vehicle in response to said vehicle limitation control signal.

32. The method of claim 31, wherein said vehicle limitation control signal is received over an SAE J1708 data bus.

33. The method of claim 31, wherein said limiting step comprises providing a limiting reference voltage to a throttle position sensor, said limiting reference voltage being less than a primary reference voltage that is provided to said throttle position sensor during normal operation.

34. The method of claim 31, wherein said limiting step comprises providing a limiting pulse train to an ECM of the vehicle, the widths of pulses making up said limiting pulse train being shorter than the widths of pulses making up a primary pulse train provided by said throttle position sensor during normal operation.

35. The method of claim 31, wherein said limiting step comprises transmitting a vehicle limitation command message over an SAE J1922 data link.

36. The method of claim 31, wherein said limiting step comprises interrupting

transmission of data from a speed sensor.

37. The method of claim 31, further comprising the steps:

determining functional characteristics a throttle position sensor of the vehicle;

if said throttle position sensor provides an output signal based upon a variable resistance, then providing a limiting reference voltage to said throttle position sensor, said limiting reference voltage being less than a primary reference voltage that is provided to said throttle position sensor during normal operation; and

if said throttle position sensor provides a pulse train output signal, then providing a limiting pulse train to an ECM of the vehicle, the widths of pulses making up said limiting pulse train being shorter than the widths of pulses making up a primary pulse train provided by said throttle position sensor during normal operation.

38. The method of claim 31, further comprising the step of ceasing to limit said operational characteristic of said vehicle only in response to the combination of receiving a vehicle limitation disengage control signal and restarting the vehicle.

39. The method of claim 31, further comprising the step of selectively disconnecting an ignition switch of the vehicle.

Abstract of the Disclosure

A system and method for selectively limiting at least one operational characteristic, such as maximum speed, of a vehicle. A vehicle limitation control signal is supplied to the vehicle over a wireless communication network. In response to the limitation control signal, the maximum speed of the vehicle is limited.

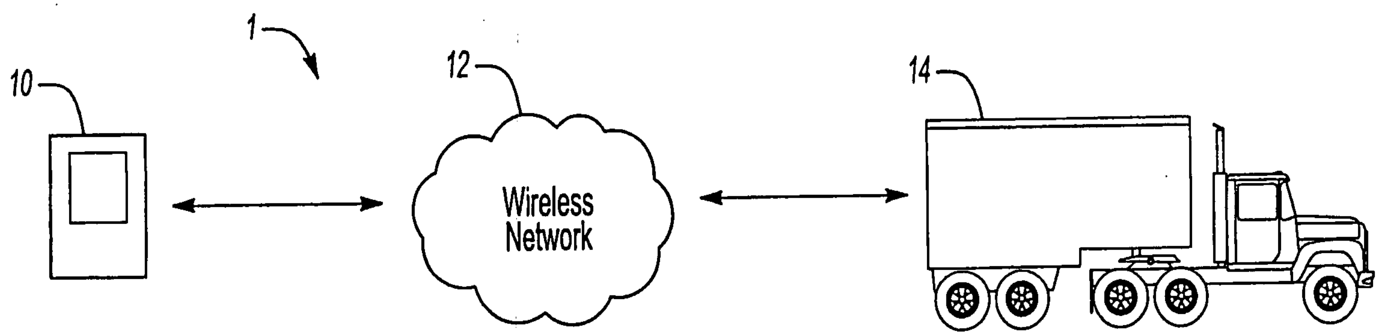
1
10
12
Wireless
Network
14

Fig-1

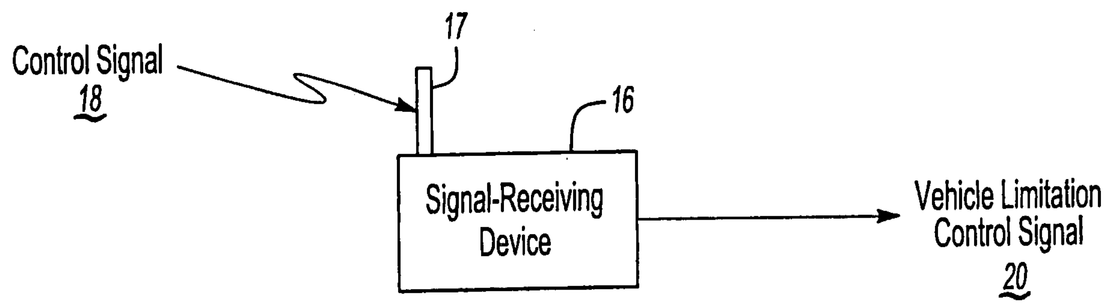
Control Signal
18
17
16
Signal-Receiving
Device
Vehicle Limitation
Control Signal
20

Fig-2

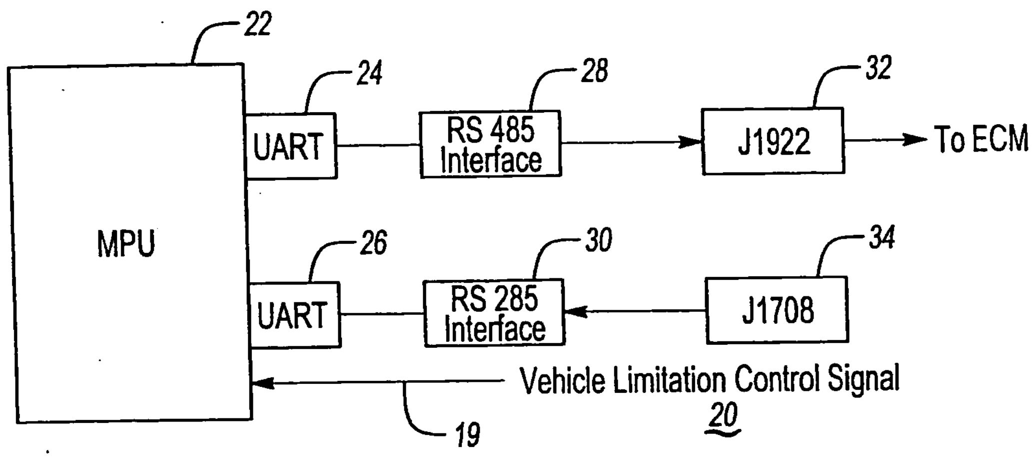
22
24
28
32
UART
RS 485 Interface
J1922
To ECM
MPU
26
30
34
UART
RS 285 Interface
J1708
Vehicle Limitation Control Signal
20
19

Fig-3

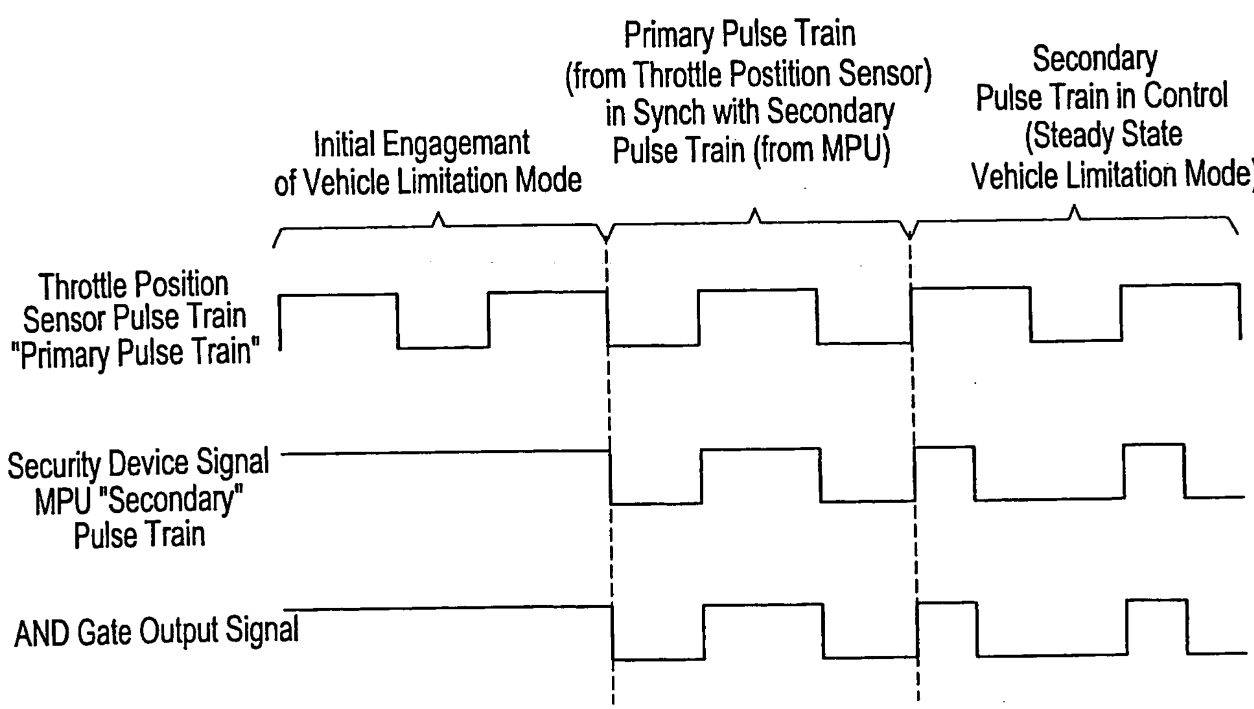
Initial Engagemant of Vehicle Limitation Mode
Primary Pulse Train (from Throttle Postition Sensor) in Synch with Secondary Pulse Train (from MPU)
Secondary Pulse Train in Control (Steady State Vehicle Limitation Mode)
Throttle Position Sensor Pulse Train "Primary Pulse Train"
Security Device Signal MPU "Secondary" Pulse Train
AND Gate Output Signal

Fig-6

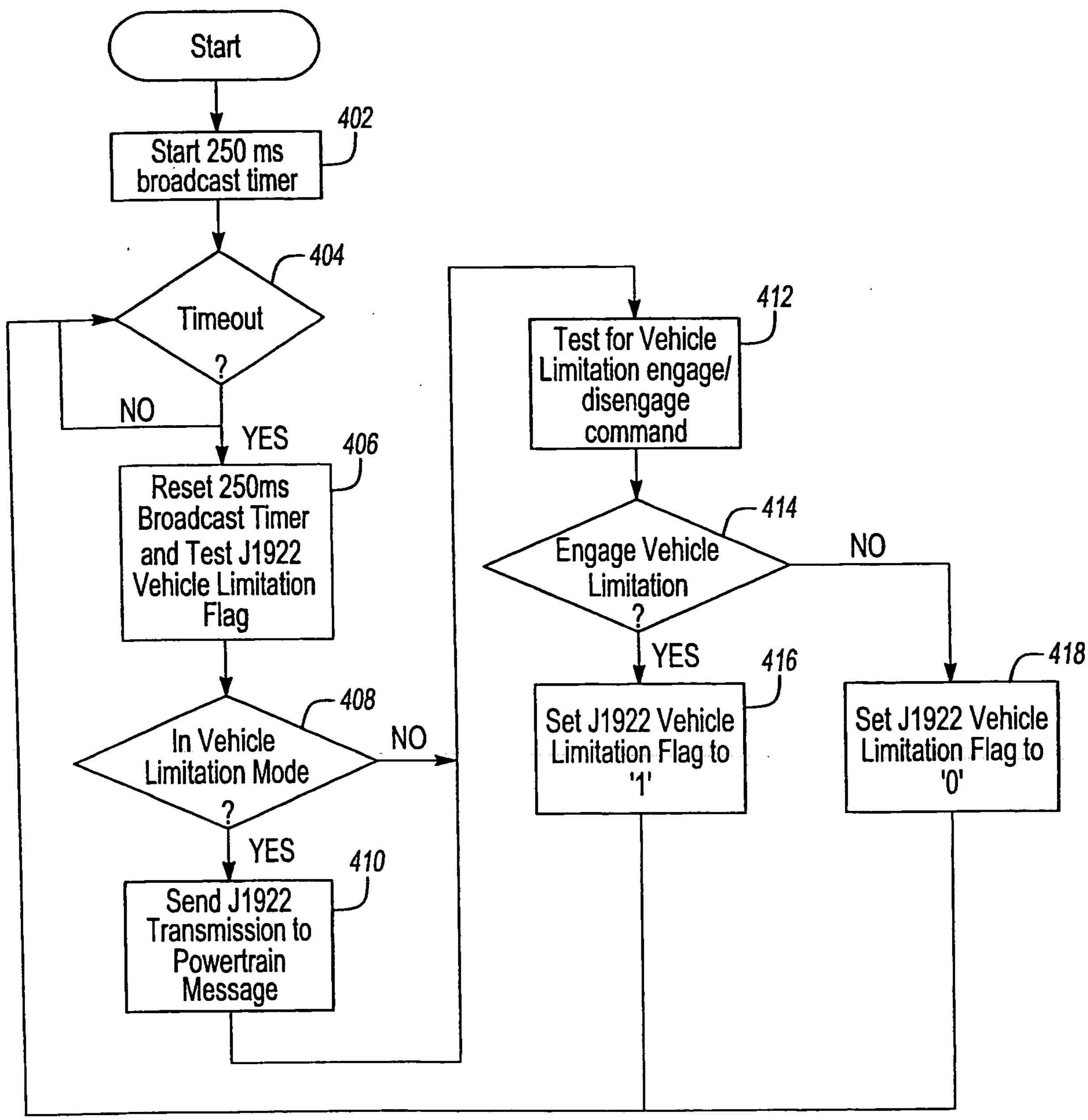
Start
Start 250 ms broadcast timer
402
Timeout ?
404
NO
YES
Reset 250ms Broadcast Timer and Test J1922 Vehicle Limitation Flag
406
In Vehicle Limitation Mode ?
408
NO
YES
Send J1922 Transmission to Powertrain Message
410
Test for Vehicle Limitation engage/ disengage command
412
Engage Vehicle Limitation ?
414
NO
YES
Set J1922 Vehicle Limitation Flag to '1'
416
Set J1922 Vehicle Limitation Flag to '0'
418

Fig-4

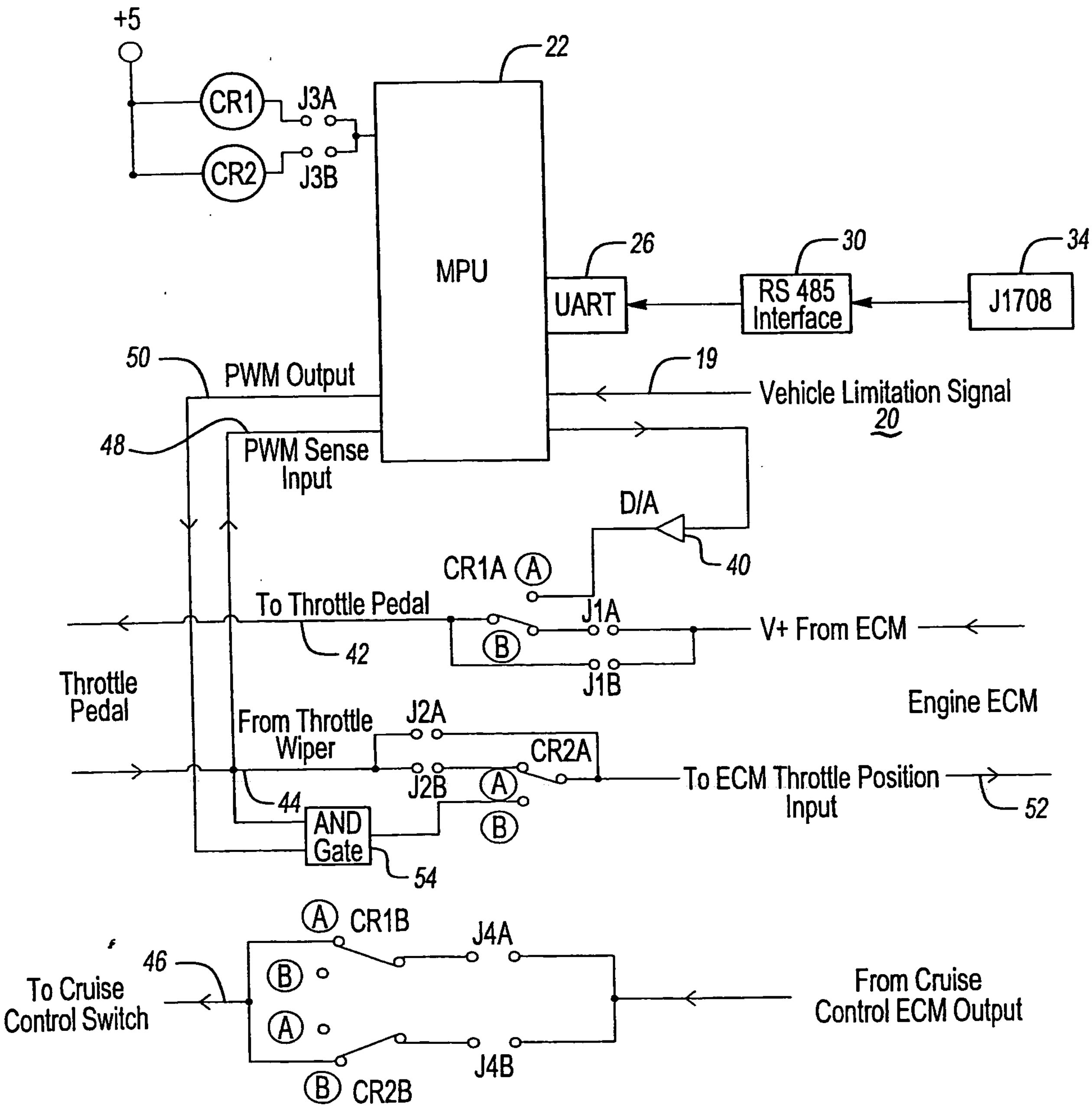
+5
22
CR1
J3A
CR2
J3B
MPU
26
UART
30
RS 485
Interface
34
J1708
50
PWM Output
19
Vehicle Limitation Signal
20
48
PWM Sense
Input
D/A
40
CR1A
A
To Throttle Pedal
J1A
V+ From ECM
42
B
J1B
Throttle
Pedal
Engine ECM
From Throttle
Wiper
J2A
CR2A
J2B
A
To ECM Throttle Position
Input
44
52
AND
Gate
B
54
A
CR1B
J4A
46
B
To Cruise
Control Switch
From Cruise
Control ECM Output
A
B
CR2B
J4B

Fig-5

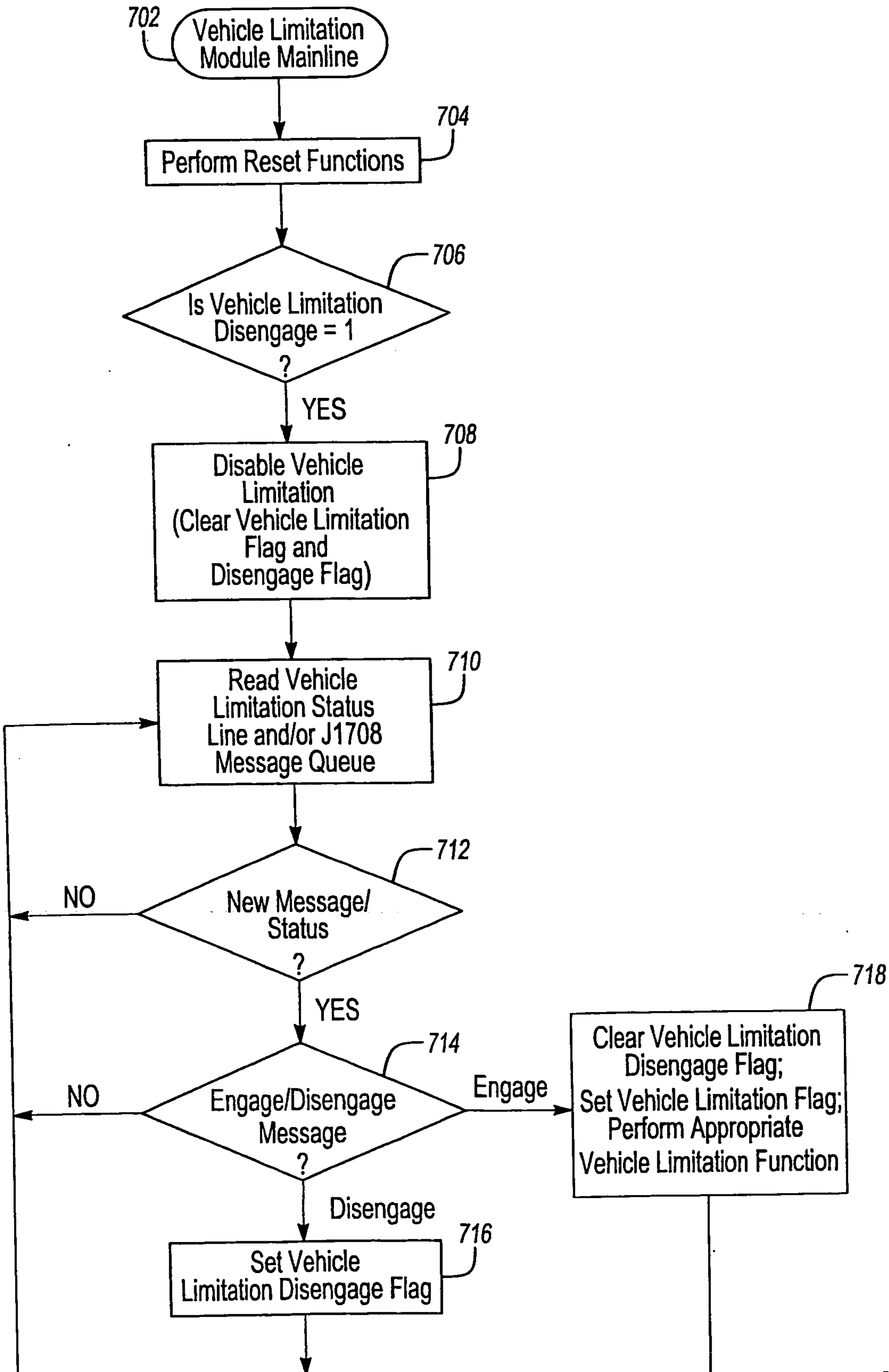
702
Vehicle Limitation Module Mainline
704
Perform Reset Functions
706
Is Vehicle Limitation Disengage = 1 ?
YES
708
Disable Vehicle Limitation (Clear Vehicle Limitation Flag and Disengage Flag)
710
Read Vehicle Limitation Status Line and/or J1708 Message Queue
712
New Message/ Status ?
NO
YES
714
Engage/Disengage Message ?
NO
Engage
718
Clear Vehicle Limitation Disengage Flag; Set Vehicle Limitation Flag; Perform Appropriate Vehicle Limitation Function
Disengage
716
Set Vehicle Limitation Disengage Flag

Fig-7

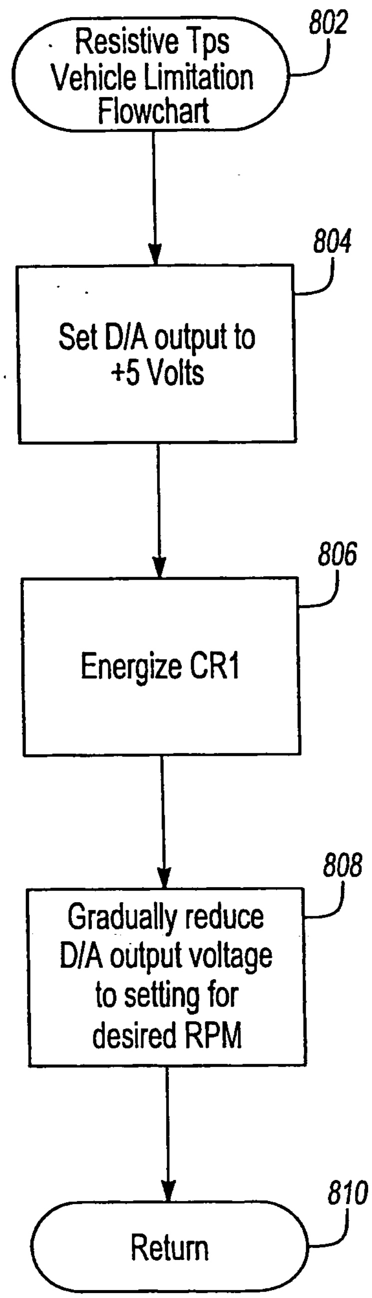
Resistive Tps Vehicle Limitation Flowchart
802
Set D/A output to +5 Volts
804
Energize CR1
806
Gradually reduce D/A output voltage to setting for desired RPM
808
Return
810

Fig-8

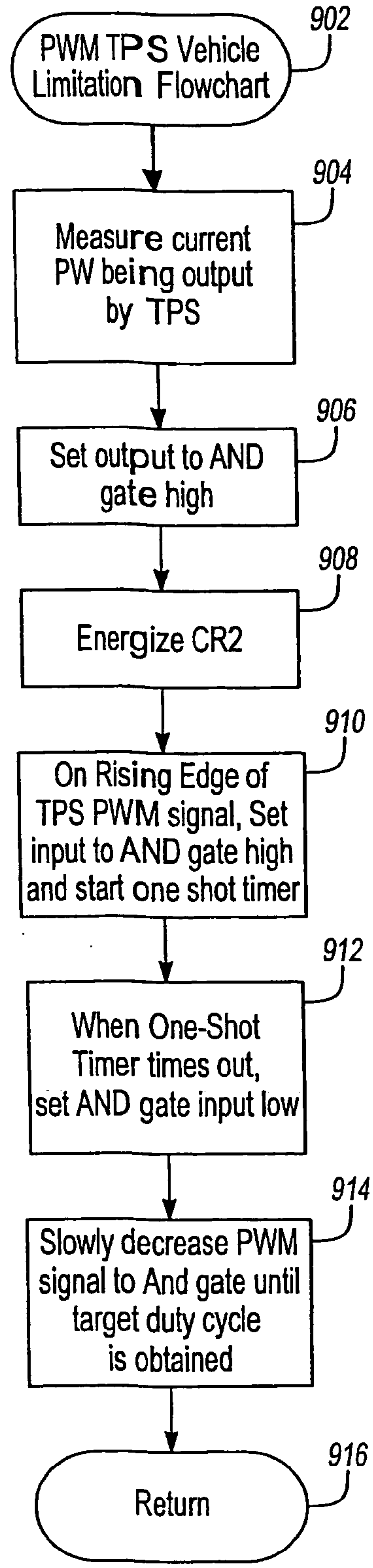
PWM TPS Vehicle Limitation Flowchart
902
Measure current PW being output by TPS
904
Set output to AND gate high
906
Energize CR2
908
On Rising Edge of TPS PWM signal, Set input to AND gate high and start one shot timer
910
When One-Shot Timer times out, set AND gate input low
912
Slowly decrease PWM signal to And gate until target duty cycle is obtained
914
Return
916

Fig-9

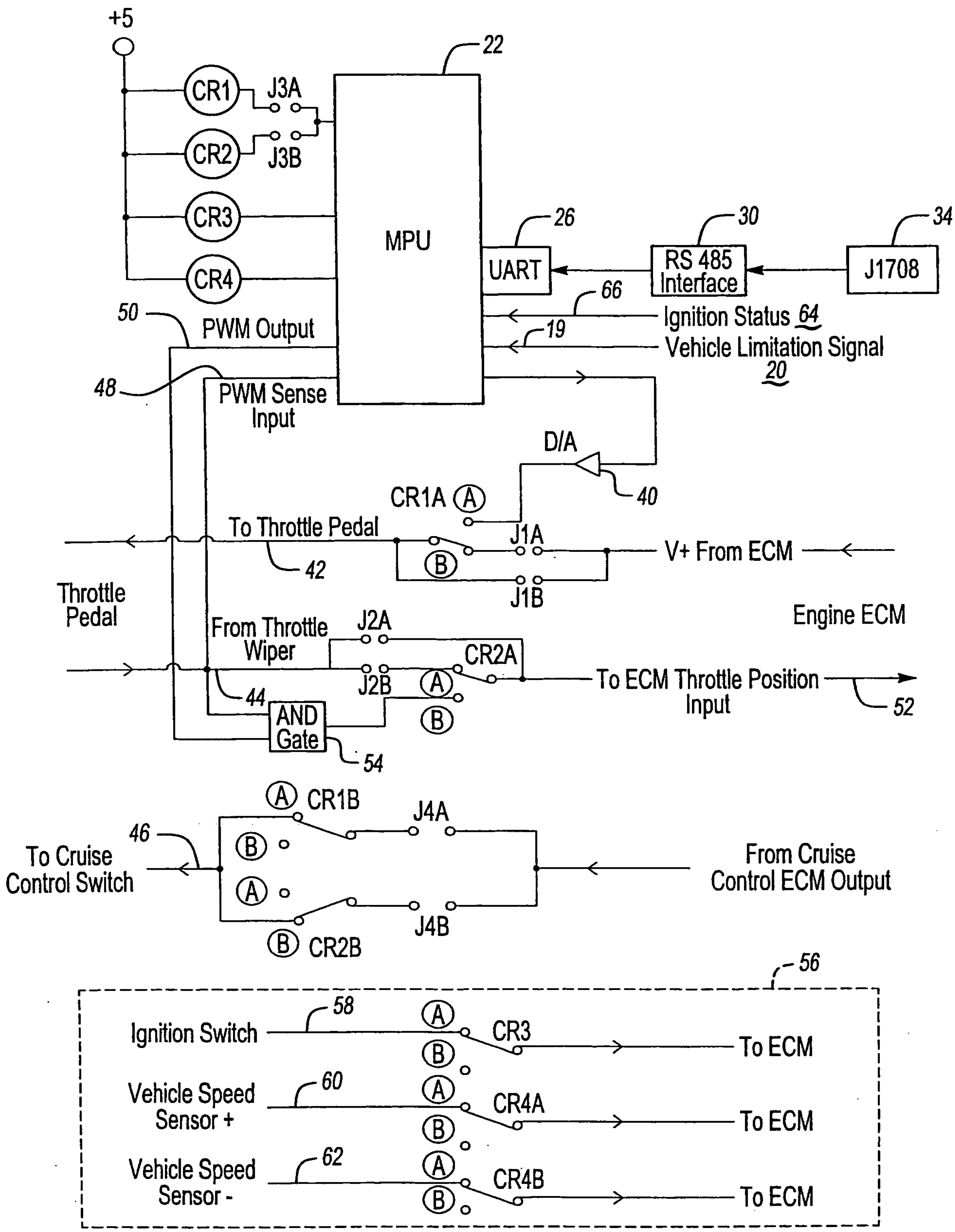
+5
CR1
CR2
CR3
CR4
J3A
J3B
22
MPU
26
UART
30
RS 485
Interface
34
J1708
66
Ignition Status 64
19
Vehicle Limitation Signal
20
50
PWM Output
48
PWM Sense
Input
D/A
40
CR1A
A
To Throttle Pedal
42
J1A
B
V+ From ECM
J1B
Throttle
Pedal
Engine ECM
From Throttle
Wiper
J2A
CR2A
44
J2B
A
AND
Gate
B
To ECM Throttle Position
Input
52
54
A
CR1B
J4A
46
To Cruise
Control Switch
B
A
From Cruise
Control ECM Output
J4B
B
CR2B
56
58
Ignition Switch
A
CR3
B
To ECM
60
Vehicle Speed
Sensor +
A
CR4A
B
To ECM
62
Vehicle Speed
Sensor -
A
CR4B
B
To ECM

Fig-10